

9010

Multifunction Calibrator



HIGHLIGHTS

- AC/DC voltage/current up to 1050V/20A
- Basic uncertainty 35 ppm
- AC/DC power, energy, resistance, capacitance, frequency, TC, RTD
- Scope option up to 400 MHz
- High voltage resistance option for 1.5 kV insulation testers
- Built-in process multimeter
- Interface RS232, LAN, USB, GPIB

DESCRIPTION

The Model 9010 Multifunction Calibrator is designed as a universal calibration tool for electrical calibration laboratories, covering most of their workload like multimeters clamp meters, ohm meters, power meters and power analyzers, energy meters, transducers, insulation testers, process meters, scopes and many others. High load capacity of both voltage (up to 50 mA) and current output allows for calibration of high-consumption analogue meters. Installed harmonic and non-harmonic shape signals allow for testing meter sensitivity to distorted signals by a signal with various crest factor. Advancing from previous M14x calibrator The 9010 can now calibrate even 400 MHz scopes, 1.5 kV insulation testers and 1 MW power meters. On the other hand we kept all the popular functions including complete transducer and external sensor calibration (strain gauge, pressure, torsion, strength, etc.) using built-in multimeter, automatic uncertainty calculation, remote control and easy recalibration.

The Model 9010 is fully compatible with the Meatest calibration SW package CALIBER/WinQbase which allows for time saving automated calibrations using any of the four installed remote control interfaces.

SPECIFICATION

Specifications below describe 1-year absolute uncertainty at a confidence interval of 95%, including long-term stability, linearity, load and line regulation and reference standard measurement uncertainty as well as ambient conditions within specified limits.

DC/AC Voltage

| | |
|-----------------------------------|---|
| Voltage range summary | DC: 0 mV – 1050 V AC sine: 1 mV _{rms} – 1050 V _{rms} Non-sine: 1 mV _{rms} – 200 V _{rms} |
| Internal ranges | 20 mV, 200 mV, 2 V, 20 V, 280 V, 1050 V |
| Frequency accuracy and resolution | 25 ppm, 5 digit |
| Non-sine waveform types | saw, triangle, square, truncated sin; 1kHz max. |
| Non-sine amplitude uncertainty | 0.3 % of range + 50 μV _{rms} |
| Voltage output modes | passive 50Ω output up to 200 mV _{dc} active output in all DC and AC ranges |

Ranges, resolution, 1 year uncertainty [ppm of value]

| Range | DC | 15 Hz – 10 kHz | 10 kHz – 30 kHz | 30 kHz – 100 kHz | 100 kHz – 300 kHz |
|----------------------------|---------------|----------------|-----------------|------------------|-------------------|
| 0.00000 – 20.00000 mV | 220 + 3 μV *1 | 2000 + 30 μV | 2000 + 40 μV | 10000 + 100 μV | 50000 + 900 μV |
| 20.00001 – 200.00000 mV | 45 + 3 μV *1 | 1000 + 80 μV | 1500 + 120 μV | 3000 + 300 μV | 5000 + 1 mV |
| 0.200001 – 2.000000 V | 35 + 10 μV | 250 + 120 μV | 500 + 300 μV | 2000 + 1 mV | 5000 + 1 mV |
| 2.00001 – 20.00000 V | 35 + 40 μV | 250 + 700 μV | 500 + 1.5 mV | 2000 + 10 mV | N/A |
| 20.00001 – 100.00000 V | 42 + 250 μV | 270 + 5 mV | 500 + 15 mV | N/A | N/A |
| 100.00001 – 280.00000 V *2 | 42 + 500 μV | 300 + 12 mV | 500 + 50 mV | N/A | N/A |
| 280.001 – 1050.000 V *3 | 50 + 7 mV | 420 + 85 mV | N/A | N/A | N/A |

*1 Uncertainty in passive mode. Active mode uncertainty is 220 ppm + 20 μV and 45 ppm + 20 μV respectively.

*2 Frequency is limited to 15 – 10 kHz above 200 V.

*3 Frequency is limited to 20 – 1 kHz.

Distortion and Load Characteristics

| Parameter | Range | 20mV | 200mV | 2V | 20V | 100 V | 280V | 1000V |
|----------------|---------------|-----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|---------------------|
| THD + noise *4 | 15 – 45 Hz | 0.05 % + 200 μV | 0.05 % + 300 μV | 0.15 % | 0.15 % | 0.15 % | 0.15 % | 0.25 % |
| | 45 – 10000 Hz | 0.05 % + 200 μV | 0.05 % + 300 μV | 0.05 % | 0.05 % | 0.05 % | 0.05 % | 0.20 % |
| | 10 – 30 kHz | 0.25 % + 200 μV | 0.25 % + 300 μV | 0.12 % | 0.15 % | 0.3 % | 0.3 % | N/A |
| | 30 – 100 kHz | 0.35 % + 230 μV | 0.35 % + 300 μV | 0.22 % | 0.3 % | N/A | N/A | N/A |
| | 100 – 300 kHz | 1.5 % + 500 μV | 1 % + 700 μV | 0.7 % | N/A | N/A | N/A | N/A |
| Burden current | DC active | 1 mA | 5 mA | 30 mA | 50 mA | 50 mA | 50 mA | 5 mA |
| | 45 – 10000 Hz | 0.5 mA _{rms} | 4 mA _{rms} | 30 mA _{rms} | 50 mA _{rms} | 50 mA _{rms} | 40 mA _{rms} | 3 mA _{rms} |
| | 10 – 30 kHz | 0.5 mA _{rms} | 4 mA _{rms} | 10 mA _{rms} | 10 mA _{rms} | 10 mA _{rms} | 10 mA _{rms} | N/A |
| | 30 – 100 kHz | 0.5 mA _{rms} | 2 mA _{rms} | 5 mA _{rms} | 5 mA _{rms} | N/A | N/A | N/A |
| | 100 – 300 kHz | 100 Ω min. load | 100 Ω min. load | 1 mA | N/A | N/A | N/A | N/A |

*4 THD in bandwidth up to 500 kHz or 10 lowest harmonics.

DC/AC Current

| | |
|-----------------------------------|--|
| Current range summary | DC: 0.0000 μA – 20.00000 A AC Sine: 10.0000 μA _{rms} – 20.00000 A _{rms} Non-sine: 100.0000 μA _{rms} – 2.000000 A _{rms} |
| Internal ranges | 200 μA, 2 mA, 20 mA, 200 mA, 2 A, 20 A |
| Frequency accuracy and resolution | 25 ppm, 5 digit |
| Non-sine waveform types | saw, triangle, square, truncated sin; 1kHz max. |
| Non-sine amplitude uncertainty | 0.3 % of range + 0.5 μA _{rms} |

Ranges, resolution, 1 year uncertainty [% of value]

| Range | DC | 15 Hz – 1 kHz | 1 kHz – 5 kHz | 5 kHz – 10 kHz |
|---------------------------|--------------------|--------------------|-------------------|-------------------|
| 0.0000 – 200.0000 μ A | 0.05 + 20 nA | 0.15 + 150 nA | 0.3 + 200 nA | 0.5 + 500 nA |
| 0.200000 – 2.000000 mA | 0.028 + 100 nA | 0.085 + 300 nA | 0.2 + 1 μ A | 0.5 + 1.4 μ A |
| 2.000000 – 20.000000 mA | 0.015 + 600 nA | 0.05 + 2 μ A | 0.2 + 10 μ A | 0.5 + 14 μ A |
| 20.0000 – 200.0000 mA | 0.015 + 6 μ A | 0.05 + 20 μ A | 0.2 + 100 μ A | 0.5 + 140 μ A |
| 0.200000 – 2.000000 A | 0.02 + 130 μ A | 0.07 + 200 μ A | 0.2 + 500 μ A | N/A |
| 2.00000 – 20.00000 A *3 | 0.025 + 2 mA | 0.1 + 6 mA | N/A | N/A |

Distortion and Load Characteristics

| Parameter | Range | 200 μ A | 2 mA | 20 mA | 200 mA | 2 A | 20 A |
|-----------------------|----------------|-------------|-------------|-------------|-------------|---------------|-------------|
| Max. inductive load | 15 Hz – 10 kHz | 1 H | 100 mH | 100 mH | 10 mH | 1 mH | 500 μ H |
| | 15 – 1000 Hz | 0.2 % | 0.2 % | 0.2 % | 0.2 % | 0.2 % | 0.3 % |
| | 1 – 5 kHz | 0.2 % | 0.2 % | 0.2 % | 0.2 % | 0.2 % | N/A |
| | 5 – 10 kHz | 0.5 % | 0.4 % | 0.4 % | 0.4 % | N/A | N/A |
| Compliance voltage *6 | DC | 5 V | 5 V | 10 V | 10 V | 5 V | 5 V |
| | 15 – 1000 Hz | 4 V_{rms} | 4 V_{rms} | 5 V_{rms} | 5 V_{rms} | 3.5 V_{rms} | 3 V_{rms} |
| | 1 – 5 kHz | 4 V_{rms} | 4 V_{rms} | 5 V_{rms} | 5 V_{rms} | 3.5 V_{rms} | N/A |
| | 5 – 10 kHz | 2 V_{rms} | 2 V_{rms} | 2 V_{rms} | 2 V_{rms} | N/A | N/A |

*5 THD in bandwidth up to 100 kHz

*6 Additional uncertainty for compliance voltage above 0.5 V_{rms}

Voltage from current

| | |
|-----------------------|--------------------------------|
| Voltage range | 5.00000 mV – 5.000000 V |
| Waveform | DC, 15.000 Hz – 400.00 Hz sine |
| Amplitude uncertainty | 0.05 % + 0.04 % of range |
| Distortion | < 0.1 % in 100 kHz bandwidth |
| Source impedance | 2.2, 22 or 220 Ω |

Current coil (option 140-50)

| | |
|------------------------|--|
| Applicable multiplier | 2 – 200 |
| Max. simulated current | multiplier · 20 A (1000 A with 140-50 Current Coil) |
| Frequency range | 45 – 65 Hz |
| Additional uncertainty | 0.25 % |

AC/DC Power & Energy

| | |
|---------------------------|---|
| Range summary | power: 40 μ W – 5.6 kW voltage: 0.2 V – 280 V current: 0.2 mA – 20 A frequency: DC, 15 – 1000 Hz time period: 10 s – 1999 s |
| Total uncertainty | based on voltage, current, phase shift and energy period specifications. |
| Phase shift uncertainty | 0.15° up to 200 Hz 0.25° above 200 Hz |
| Energy period uncertainty | 0.01% + 0.3 s |
| Additional features | Harmonic distortion, voltage from current, current coil multiplication |

Total 1 year uncertainty overview [% of value]

| Current range | DC | 15 Hz – 1 kHz, $\phi = 0^\circ$ | 15 Hz – 200 Hz, $\phi = 60^\circ$ |
|---------------|-----------------|---------------------------------|-----------------------------------|
| 2 mA | 0.035 – 0.079 % | 0.11 – 0.25 % | 0.47 – 0.52 % |
| 20 mA, 200 mA | 0.021 – 0.047 % | 0.073 – 0.18 % | 0.46 – 0.49 % |
| 2 A | 0.029 – 0.086 % | 0.090 – 0.19 % | 0.46 – 0.49 % |
| 20 A | 0.037 – 0.13 % | 0.14 – 0.41 % | 0.47 – 0.61 % |

Resistance

Resistance range summary

0.0000 Ω – 100.0000 kΩ in 4W
0.0000 Ω – 1.000000 GΩ in 2W

Modes

2W and 4W continuous range
2W and 4W fixed decadic standards
100 GΩ High Voltage Resistance (optional)

Basic resistance modes and 1 year uncertainty [ppm of value]

| Continuous range mode | 4W | 2W | Nominal standard value | 4W | 2W |
|-----------------------|--------------|--------------|------------------------|----------|--------|
| 0 – 10 Ω | 300 + 1 mΩ | 300 + 131 mΩ | 0 Ω | < 0.2 mΩ | 0.2 Ω |
| 10 – 33 Ω | 250 + 1 mΩ | 250 + 131 mΩ | 1 Ω | 200 | 0.05 Ω |
| 33 – 100 Ω | 150 + 1 mΩ | 150 + 131 mΩ | 10 Ω | 20 | 0.05 Ω |
| 100 – 1000 Ω | 100 + 3 mΩ | 100 + 133 mΩ | 100 Ω | 15 | 150 |
| 1 – 10 kΩ | 100 + 30 mΩ | 100 + 160 mΩ | 1 kΩ | 15 | 15 |
| 10 – 100 kΩ | 100 + 300 mΩ | 100 + 430 mΩ | 10 kΩ | 15 | 15 |
| 100 – 330 kΩ | 100 + 3 Ω | 100 + 3 Ω | 100 kΩ | 15 | 15 |
| 330 – 1000 kΩ | 150 + 3 Ω | 150 + 3 Ω | 1 MΩ | - | 30 |
| 1 – 3.3 MΩ | - | 150 + 30 Ω | 10 MΩ | - | 500 |
| 3.3 – 10 MΩ | - | 200 + 30 Ω | 100 MΩ | - | 1000 |
| 10 – 33 MΩ | - | 1000 + 300 Ω | 1 GΩ | - | 2500 |
| 33 – 100 MΩ | - | 2000 + 300 Ω | | | |
| 100 – 330 MΩ | - | 3000 + 300 Ω | | | |
| 330 – 1000 MΩ | - | 7000 + 1 kΩ | | | |

Capacitance

Capacitance range summary

0.800000 nF – 120.0000 mF in 2W

Modes

2W continuous range
2W fixed decadic standards

Capacitance modes, 1 year uncertainty and frequency limits

| Continuous range mode | Uncertainty | Nominal standard value | Uncertainty |
|-----------------------|---------------|------------------------|-------------|
| 0.8 – 3.3 nF | 0.5 % + 15 pF | 1 nF | 2.5 % |
| 3.3 nF – 10 μF | 0.5 % | 10 nF | 0.35 % |
| 10 – 33 μF | 1.5 % | 100 nF | 0.25 % |
| 33 – 100 μF | 2.5 % | 1 μF | 0.25 % |
| 0.1 – 1 mF | 3 % | 10 μF | 0.35 % |
| 1 – 120 mF | 5 % | 100 μF | 0.8 % |

Harmonic distortion

Number of products:

50

Fundamental harmonic range

1 mV – 200 V or 10 μA – 2 A at 15 – 1000 Hz

Fundamental harmonic uncertainty

amplitude: ≥ 0.2% of range
frequency: 25 ppm
phase shift: 0.2 – 0.5 °

Harmonic product amplitude range

0 – 30 % of fundamental

Harmonic product frequency range

30 – 5000 Hz

Harmonic product phase shift unc.

5 μs (typical)

Temperature (RTD, TC)

RTD temperature standards

Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom

RTD R₀ range

20 Ω – 2 kΩ

Thermocouple types

B,C,D,E,G₂,J,K,M,N,R,S,T

TC cold junction compensation

Manual or automatic with adapter 91

Uncertainty

0.03 °C – 0.18 °C in RTD
0.18 °C – 0.96 °C in TC

| Measurement function | Range | Uncertainty |
|-------------------------------|---|--|
| DC voltage | 12 mV 120 mV, 1.2 V, 12 V | 50 ppm + 3 μ V 50 ppm + [5 – 500] μ V |
| DC current | 100 μ A, 1 mA 2.4 mA, 24 mA | 200 ppm + [20 – 100] nA 150 ppm + 800 nA |
| Frequency | 0.1 Hz – 100 kHz | 50 ppm |
| Resistance ^{*7} | 2 k Ω , 20 k Ω | 200 ppm + 5 ppm of range |
| RTD temperature ^{*7} | Pt3850, Pt3851, Pt3916, Pt3926, Ni120, custom | 0.08 – 0.42 $^{\circ}$ C |
| TC temperature | BCDEG ₂ JKMNRST | 0.22 – 1 $^{\circ}$ C |

*7 Using 9000-60 4W measurement adapter (comes as standard with MER option)

9010/SC Frequency / Scope option

HF mode (levelled sine)

Amplitude range:

1.400 mV_{pk} – 1.5000 V_{pk}

| Freq. range | 20 Hz – 100 kHz | 100 – 500 kHz | 0.5 – 10 MHz | 10 – 100 MHz | 100 – 400 MHz |
|---------------------|--------------------------------------|---------------|--------------|--------------|---------------|
| Harmonic distortion | -55 dB | -38 dB | -38 dB | -38 dB | -30 dB |
| Flatness | < 0.2 % | < 0.7 % | < 1.2 % | < 2.0 % | < 2.5 % |
| Uncertainty | 0.5 % + 350 μ V _{pk} | 2.0 % | 2.5 % | 3.3 % | 3.7 % |

LF mode (DC, square wave)

High voltage range:

up to 200 V_{pk} at 1 kHz, 0.3 % amplitude uncertainty

Low voltage range:

up to 10.5 V_{pk} at 100 kHz, 0.1 – 0.2 % amp. uncertainty

PULSE WIDTH and
TIME MARKER modes

Frequency range:

0.1 Hz – 400 MHz

Frequency uncertainty:

2.5 ppm

Amplitude ranges:

50 mV_{pk}, 100 mV_{pk}, 500 mV_{pk}, 1 V_{pk}

Duty cycle ratios:

1 %, 10 %, 20 %, 30 %, 40 %, 50 %

TM waveforms:

PWM up to 25 MHz, 2 ns spike otherwise

Jitter:

< 2 ns

Rise time:

< 1 ns

TRIGGER mode

Amplitude:

> 1 V_{pk}

Division ratio:

off, /1, /10, /100

Rise time:

< 1 ns

9010/HR High Voltage Resistance option

| Range | Maximum test voltage | Resistance uncertainty | Test voltage uncertainty |
|---------------------------------|----------------------|------------------------|--------------------------|
| 100 – 200 k Ω | 800 V _{dc} | 0.2 % | 0.3 % + 2 V |
| 200 k Ω - 1 M Ω | 1100 V _{dc} | 0.2 % | 0.3 % + 2 V |
| 1 – 10 M Ω | 1150 V _{dc} | 0.3 % | 0.5 % + 5 V |
| 10 M Ω – 1 G Ω | 1575 V _{dc} | 0.5 % | 0.5 % + 5 V |
| 1 – 10 G Ω | 1575 V _{dc} | 1.0 % | 1 % + 5 V |
| 100 G Ω (fixed standard) | 1575 V _{dc} | 3.0 % | 1.5 % + 5 V |

GENERAL DATA

| | |
|-------------------------|------------------------------------|
| Warm-up time | 30 minutes |
| Reference temperature | +22 °C – +24 °C |
| Operating temperature | +13 °C – +33 °C |
| Storage temperature | -10 °C – +55 °C |
| Temperature coefficient | 10 % of accuracy / °C outside Tref |
| Max relative humidity | 70 % |
| Power supply | 115/230V - 50/60 Hz, 450 VA max |
| Dimensions (W x H x D) | 435 x 175 x 620 mm |
| Weight | 24 kg |
| Interfaces | RS232, IEEE488, USB, Ethernet |